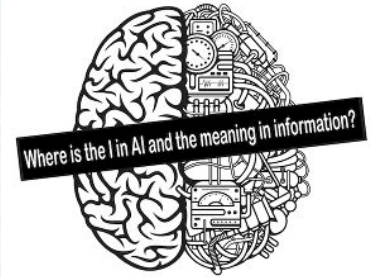


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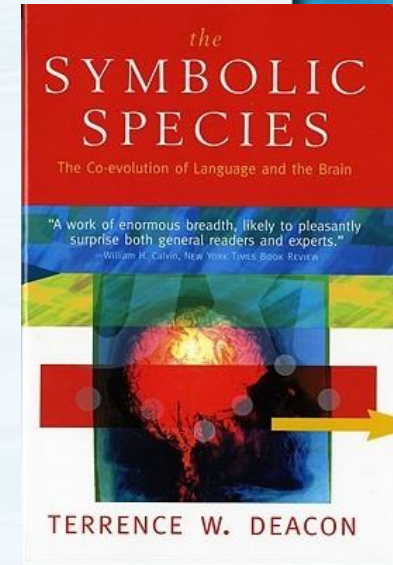


Birth and Evolution of Symbolic Information in the Human Being

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Script

1. Introduction
2. Basic idea of the transition from hominids to humans
3. Foundations of Deacon's theory (*Symbolic Species*, 1997)
4. Further developments of its foundations
5. Paradigmatic case of the Bengales Finch
6. Very special conditions for the born of 1st symbolic information system
7. Key changes from first symbolic systems to language
8. Conclusion



Introduction

Objectives:

- To present main points of Deacon's theory of language evolution as presented in *The Symbolic Species* (1997)
- To present further developments of its foundations
- A re-examination of the emergence of first symbolic systems

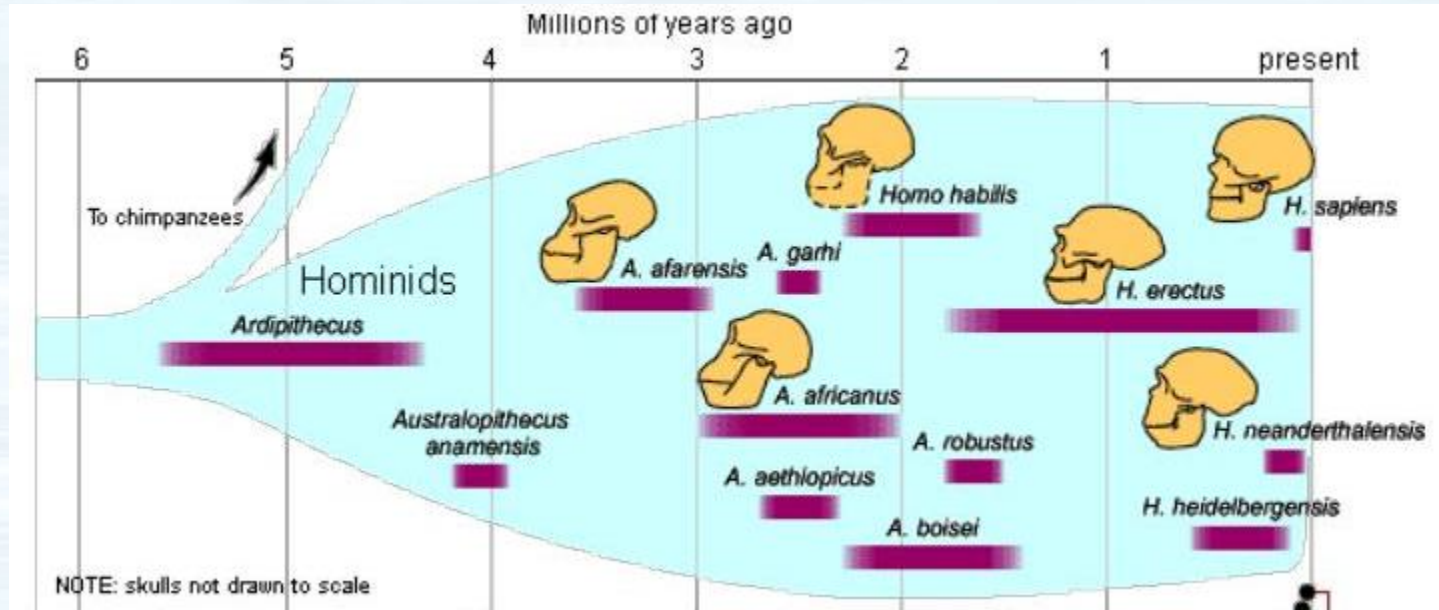
Motivations:

- To spread Deacon's theory
- To learn more deeply his theory

Basic idea of the transition

1. Chapter 12 of *The Symbolic Species*
2. Symbolic use was born in hominids from at least 2 millions years ago
3. Language is too complex to evolve quickly
4. Not enough time to be biologically developed until our language
5. Basic idea:
 - More cooperative social life among earlier hominids
 - First very simple symbolic systems around 2 millions years ago
 - Long evolution of 1st symbolic systems until our language
 - Appearance of the human species with its unique language

Hominids Evolution Timeline



Foundations of Deacon's theory

Constatation: "**There is no simple language today**"

1. Peircean semiotics theory:
 - Communication is structured in nested hierarchical levels
2. Biological development is emergent:
 - Engineering fallacy: parts of organism are born from inside out
 - Linguistic fallacy: also parts of sentence are born from inside out
3. Natural selection reviewed:
 - Biological evolution does not occur only by genetic mutations

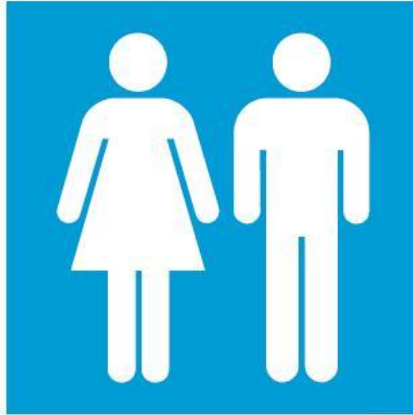
Peircean semiotics theory

1. Levels of semiotic infrastructure: **iconic, indexical and symbolic**
2. Kinds of communication: indexical and symbolic
3. Communication is structured in nested hierarchical levels:
 - Indexical communication is structured over iconic references
 - Symbolic communication emerges from indexical references
4. Animals have only various forms of indexical communication
5. Symbols and their systems are difficult to learn:
 - The case of symbolic lexigrams of chimpanzee experiments
 - Higher costs of a symbolic system

Problems of symbol conventionality



Conventional Icon



Conventional Indices



Conventional Symbols

CIGARETTE



Troubles of contemporary view of symbols

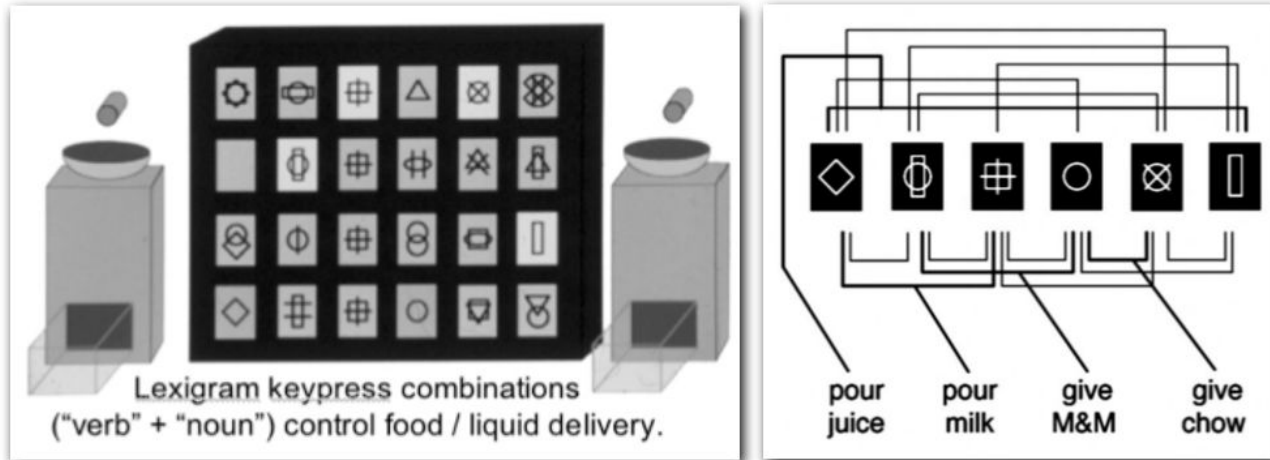
1. Confusions about the nature of symbolic reference have blocked progress to understand human language, its born and evolution
2. Confusions have led to unsolvable problems:
 - Existence of Universal Grammar (its innateness and evolvability)
 - Symbol grounding problem (how to ground arbitrary symbols?)
3. Example to elucidate the argument (experiments with chimpanzees)
4. The Engineering Fallacy is behind such faulty view

Lexigrams in experiments with chimpanzees



1. Transition from indices to symbols is demonstrated in a very simple symbolic system, learned by two chimpanzees, Sherman & Austin
2. Thousands of trials to discover symbolic reference in small 6-lexigram system (2 foods, 2 drinks, 2 action verbs: '*give*' and '*pour*')
3. The transition involved learning a system of combinatorial exclusion relations between lexigrams (food is not poured, drink is not given)

Logic of the lexigram-symbol-combination experiment

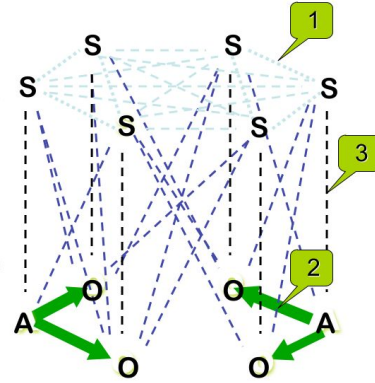


- The specific combinatorial logic was difficult to train because the chimpanzees persisted in “assuming” indexical correlations between lexigrams and results.

Acquiring symbolic reference stage 1: Sorting possible combinatorial associations

Stage 1

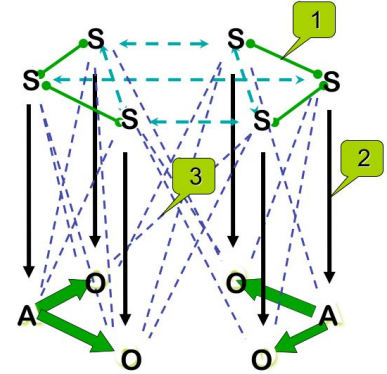
Even for a small set of sign tokens (S), the number of possible sign combinations ¹ and their correlations with objects (O) and action- A relations ² can be immense. Sorting successful from unsuccessful trials taxes working memory but may be aided by training on initially simplified false correlations ³ . . . i.e. *reductio ad absurdum*



Acquiring symbolic reference stage 2: Discovering indexical associations

Stage 2

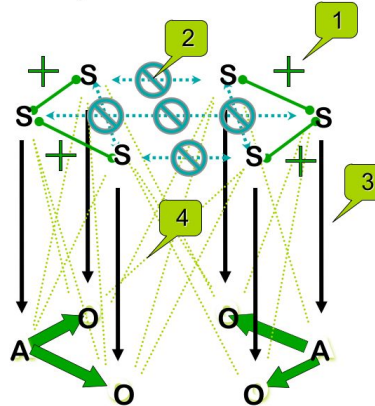
Learning to make token-token (S-S) combinations ¹ that correlate with successful indication ² (and thus acquisition) of an object O via a specific instrumental action A is supported by the memory trace of many past errors. ³



Acquiring symbolic reference stage 3: Regularizing indexical links (correlations)

Stage 3

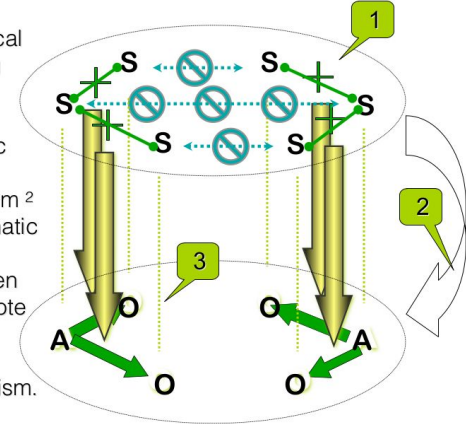
Learning all patterns of allowed token-token combinations ¹ and exclusions ² allows the learner to focus on the indexical correlations between tokens and physical consequences ³ and allows the non-correlations to be progressively ignored. ⁴



Acquiring symbolic reference stage 4: Discovering system-system iconism (relational correspondences)

Stage 4

Full system ¹ of logical relationships among symbol tokens becomes the focus. This frees mnemonic load and leads to recognition of iconism ² with physical-pragmatic relationships. This enables symbol token relationships to denote objects ³ mediated indirectly via this system-system iconism.



Some conclusions

- Iconic and indexical infrastructure is crucial for symbolic reference
- What is discovered is a symbolic system of liquid-solid classification
- Once chimpanzees learned, it became easier to add other lexigrams
- The symbolic system
 - is not imposed, it is born from inside out through trial and error
 - emerges from a system of iconic and indexical references that are used (un)successfully to get foods and drinks
- If chimpanzees are able to learn and use simple symbolic systems, earlier hominids like *homo habilis* should have been able too

The engineering fallacy

Watch

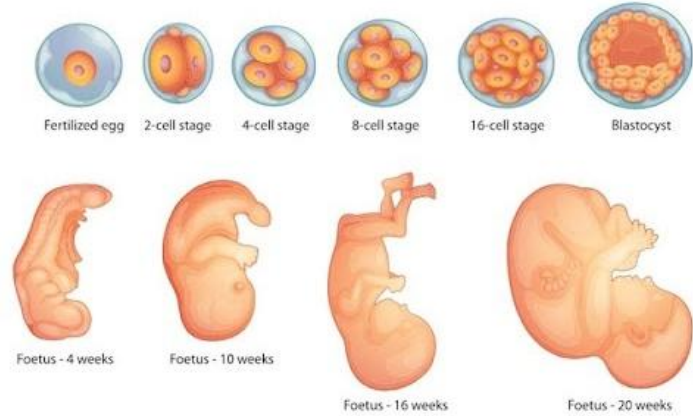


Parts are first build and then assembled

Parts precede the Whole

Human Being

Human Embryonic and Foetal Development

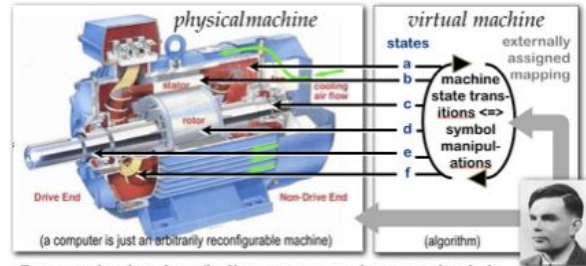
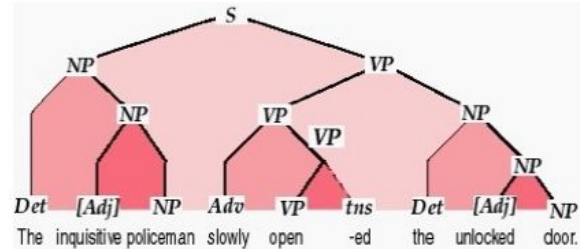


Whole precedes the Parts

It is self-organized by part-part interactions
Parts differentiate from prior integrated whole

The linguistic fallacy

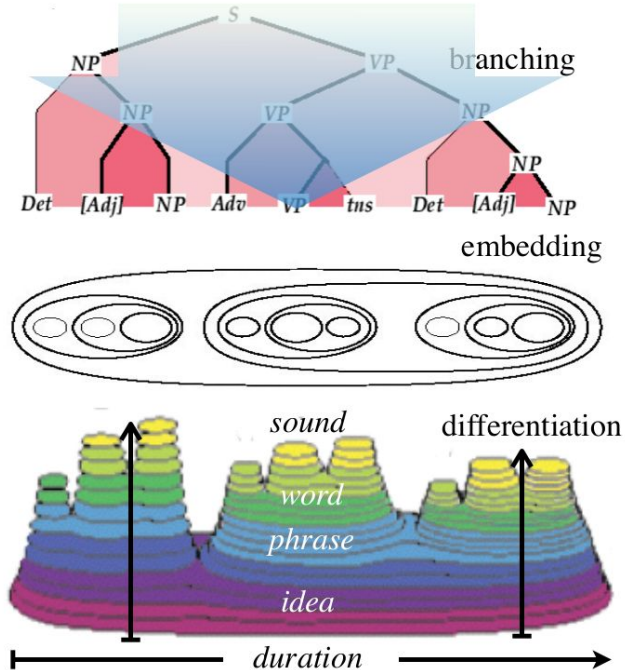
engineering logic



Computation involves finding or constructing a mechanistic isomorphism with a formal operation, etc.

**Cognition
is
Biological**

neurobiological logic



Natural selection reviewed

- DNA sets up biological points that channel self-development
- Baldwin's theory: context of selection is modified by a new behavior
- Waddington' theory: new behaviors may be genetically assimilated
- Neo-Weddington and Baldwin effects in the development of new traits

- **Masking (Baldwin)**

- **Degradation & de-differentiation**
- **Distribution of selection**
- **Increased conditionality**

- **Unmasking (Waddington)**

- **Co-assortment of synergistic traits**
- **Convergent multi-determination**
- **Canalization and meta-stability**

Beaver and its dams and lodge



Further developments of its foundations

1. Reformulation of key aspects of natural selection theory
 - Role of **Relaxed Selection** in evolution of organisms
2. Theory of the origin of teleodynamics of living beings
 - The born of the semiotic process of living – **Emergence of Self**
3. Theory of the process underlying hierarchic transitions in evolution
 - **Duplication-relaxed selection-degradation-new synergies**
4. Bio-semiotic reformulation of the Shannonian theory of information
5. Role of symbolic capacity in the emergence of art and religion
6. Studies on the metaphysics of emergent dynamics

Relaxed selection

1. Baldwin's and Waddington's mechanisms are insufficient
2. Theories of kin and group selection explain how prosocial and altruistic behaviors are kept, but don't explain how they arise in the first place
3. 3rd mechanism: **the loss of autonomy through relaxed selection**
 - It assures the maintenance of the cooperative co-dependence
 - It leads to "Social Addiction"
4. Associative or social "cooperation" become no longer a choice:
 - Cells become genetically "addicted" to multicellular organism
 - Animals become socially "addicted" to co-dependent group

2012

Emergence of Self

2017

INCOMPLETE NATURE



How Mind Emerged from Matter

TERRENCE W. DEACON

In *Symbolic Species* there was no theory of the self emergence yet

Incomplete Nature

- Origin of life and mind
- Teleodynamics
- Autogen
- Emergence of Self

Neither Ghost Nor Machine

NEITHER GHOST NOR MACHINE

The Emergence and Nature of Selves



JEREMY SHERMAN

Foreword by TERRENCE DEACON

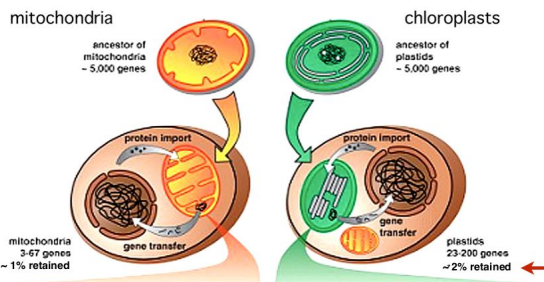
Process underlying hierarchic transitions

- Main transitions: endossimbiose, multicellularity, cooperative behavior, and language
- Main processes: epigenetic geometry effects, relaxed selection, intra selection in brain evolution, and fine-tuning of neural circuitry.
- Main types of relaxed selection: internal redundancy of intragenomic duplication, external redundancy of some function duplication, and global external redundancy (general change of environment condition)
- Pattern of the process underlying all hierarchic transitions in evolution:
Duplication-relaxed selection-degradation-new synergies

Some examples of hierarchic transitions

1. Gene duplication produces gene families that function synergistically
2. Evolution of eukaryotes via endosymbiosis (as mutual addiction)
3. Multicellularity development through epigenetic structural information
4. Duplication of regulatory genes (Homeobox genes)
5. Hemoglobin gene duplication that produces new kinds of hemoglobin
6. Organ duplication that produces new kinds of organs
7. Duplication of body structure produces new kinds of body structures
8. Degradation of vitamin-C gene in humans (from monkeys)
9. Evolution of language and culture via epigenetic symbolic information

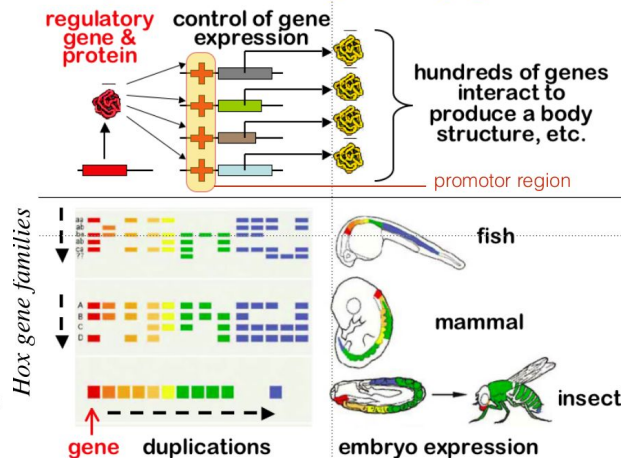
Endosymbiosis as mutual addition



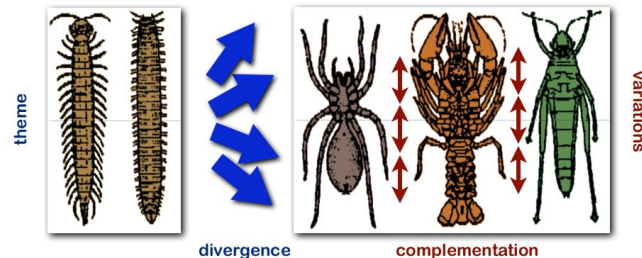
The ancestors of mitochondria and chloroplasts lost a large proportion of their genomes in the process of becoming endosymbionts. Many genes were transposed to the nucleus and many proteins critical to organelle function became produced by nuclear genes. Likewise metabolic functions carried out by organelles enabled the degradation of the nuclear genes that had previously supported them.

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Duplication of regulatory genes

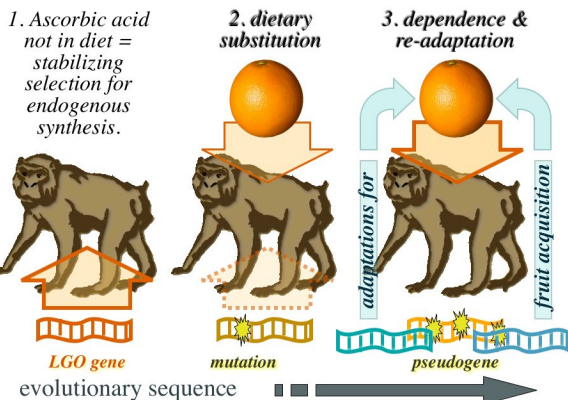


Duplication-variation of body structures

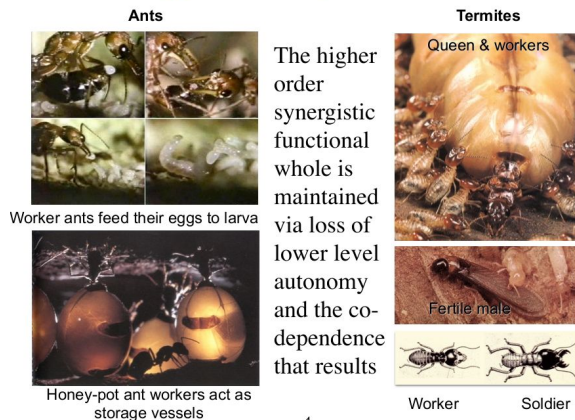


- Functional redundancy of duplicate body parts relaxes selection on others, in which accumulated mutations produce variants of structure and function.
- Variant forms will tend to diverge and may come to complement the functions of others,
- thus initiating *selection for their synergistic effects*.

Loss of vitamin C synthesis



Eusociality, altruism, loss of autonomy



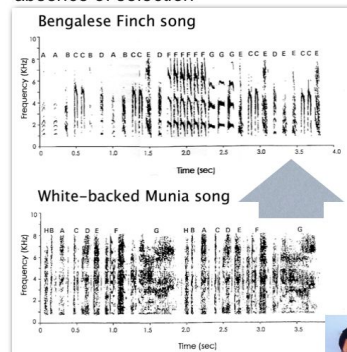
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Relaxed sexual selection & song structure



250 years of breeding for color without the effects of natural or sexual selection resulted in more complex song, social song learning, and involvement of multiple brain regions

Increased song complexity in the absence of selection



from the laboratory of Kazuo Okanoya

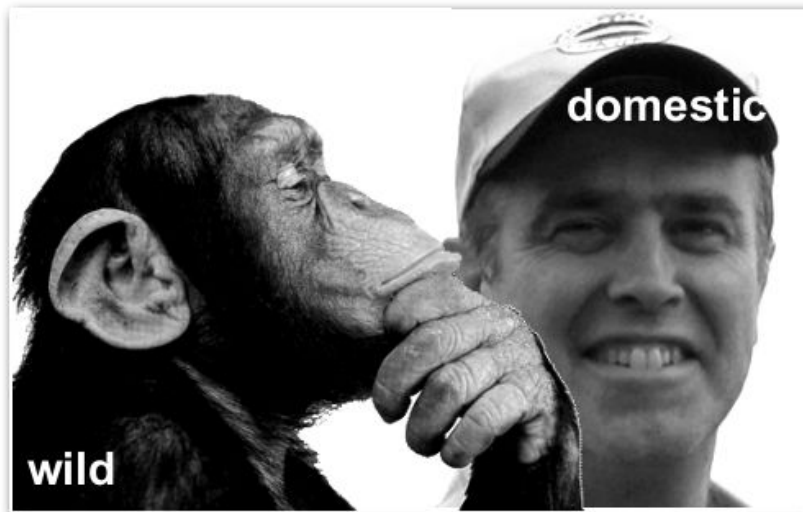


Paradigmatic case of Bengales Finch

- Bengales finch domesticated from wild White-Rump Munia
- Bred for coloration for 250 years, **not for singing**
- Paradoxical result:
 - An increased song complexity
 - Greater involvement of social learning in song development
 - More diverse neural control of singing behaviors
- Domestication masked selection that keeps control of song production
- Relaxing pressures led to degradation of strong genetic constraints
- Relaxation-degradation can lead to complexity of brain and behavior



Could humans be a self-domesticated species; i.e. a degenerate ape?



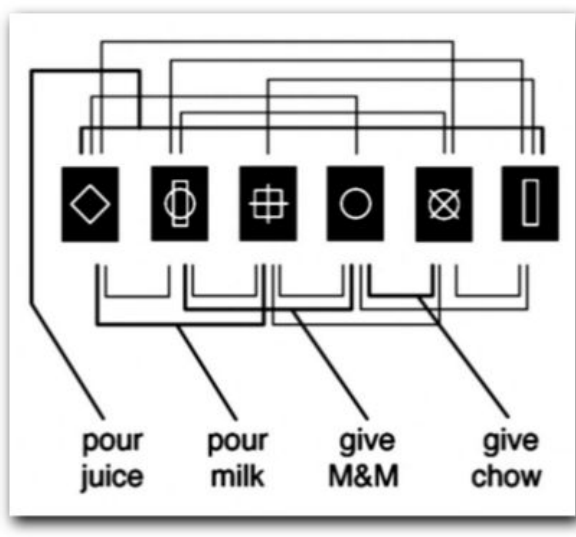
Although this suggests that language may depend on loss of innate biases rather than the introduction of an innate language faculty, these are not mutually exclusive options.

Special conditions for 1st symbolic system

1. Special social niche of earlier hominids
2. Unstable niche:
 - Male hominids hunting together for the whole group
 - Female hominids together taking care of children
 - Monogamous couples living together in small social groups
3. Hypothesis of the first symbolic system:
 - 'Mate contract' to inform symbolically who can mate whom
 - Emerged via repeated rituals with members of a hominid group
 - Simple symbols that marked the "married" couple

Emergence of 1st symbolic system

Six Lexigram Symbols



Liquid / Solid Classification

Simple Symbol of "Mate Contract"



Married / Available Classification

From 1st symbolic systems to language

Several changes that enhanced the symbolic adaptations:

- Deepening the relaxed selection with domain of fire and cooking
- Expansion of pre-frontal cortex to better control the symbol use
- Expansion memory / Specialization of some brain areas
- Fine control of breath / Descence of vocal tract to lower position
- New forms of integration between symbols and emotions

In summary:

- Language and brain have co-evolved in a new symbolic niche
- Language have developed to fit young child symbolic capabilities

Conclusion

- Advantages of Deacon's theory:
 - Avoids unsolvable problems (innate grammar, its evolvability)
 - Opens a viable scientific pathway to the origin of language
 - Opens a wide and fruitful field for new researches
- Problems:
 - Deacon's theory is not ready
 - Many steps of the language evolution has to be answered
 - Opens new issues that need more researches and new answers
- *"Analysis of Diversification of Symbolic Systems in Human Evolution"*